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Comparability of Data Obtained From Migrant Farmworkers and Their Spouses on Occupational History

Joanne S. Colt, MPH,[1]* Lawrence S. Engel, PhD,[2]† Matthew C. Keifer, MD, MPH,[3] Mary Lou Thompson, PhD,[4] and Shelia Hoar Zahm, ScD[1]

Background *Epidemiologic studies, particularly case-control studies, often rely on proxy respondents to provide information about subjects' occupational histories. The quality of proxy-reported information in occupational histories has never been evaluated for migrant farmworkers.*

Methods *We compared occupational histories self-reported by 31 farmworkers with those reported by their wives. The work histories were obtained using an icon/calendar-based questionnaire that was designed to facilitate recall for migrant farmworkers, who typically have complex work histories.*

Results *The work histories provided by proxy respondents contained 32% fewer jobs and accounted for 24% fewer years than the self-reported histories. Correlations for lifetime duration of employment in different types of jobs were moderate to good for general agricultural jobs in Washington (0.70) and apple-related jobs (0.65), which were held by virtually all of the farmworkers; correlations were moderate to poor for less common jobs and for specific types of tasks. Agreement was better after marriage than before, and for jobs held in the current year compared to other time frames. Overall, the ability of the spouses to provide occupational histories for farmworkers was within the range observed in studies involving other occupations and industries.*

Conclusions *In studies involving farmworkers, when study subjects cannot be interviewed, spouses can provide useful information on occupational histories. However, the information should be used only for more generalized exposure assessments; it is most appropriate for estimating cumulative duration of agricultural work, or recent work, by place or for common crops.* Am. J. Ind. Med. 40:523–530, 2001. © *2001 Wiley-Liss, Inc.*†

KEY WORDS: migrant farmworkers; proxy respondents; epidemiologic methods; occupational history; questionnaire; agriculture

INTRODUCTION

Studies of rapidly fatal diseases often rely on proxy respondents for information about subjects' exposures. Although several studies have examined the quality of occupational data provided by proxy respondents [Rogot and Reid, 1975; Blot et al., 1978; Pershagen and Axelson, 1982; Pickle et al., 1983; Coggon et al., 1985; Greenberg et al., 1985; Lerchen and Samet, 1986; Rocca et al., 1986; Shalat et al., 1987; Bond et al., 1988; Brown et al., 1991; Hatch et al., 1991; Boyle et al., 1992; Blair and Zahm, 1993; Johnson et al., 1993; Nelson et al., 1994; Blair et al., 1995;

[1]Division of Cancer Epidemiology and Genetics, National Cancer Institute, Bethesda, Maryland
[2]Department of Epidemiology, University of Washington, Seattle, Washington
[3]Occupational Medicine Program, Departments of Medicine and Environmental Health, University of Washington, Seattle, Washington
[4]Department of Biostatistics, University of Washington, Seattle, Washington

Abbreviations: Δ, difference; IQR, interquartile range; FW, farmworker; r, Spearman correlation coefficient.

†Lawrence S. Engel's present address is Division of Cancer Epidemiology and Genetics, National Cancer Institute, Bethesda, MD.
*Correspondence to: Joanne Colt, National Cancer Institute, Occupational Epidemiology Branch, 6120 Executive Boulevard, Room 8112, Bethesda, MD 20892-7240.
E-mail: coltj@mail.nih.gov

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Kukull et al., 1995], this issue has never been addressed for migrant farmworkers or other laborers with transient employment, who typically have complex work histories.

This study compares work histories self-reported by male farmworkers with those provided by their wives. The work histories were obtained by interviewing subjects with an icon/calendar questionnaire, which consists of a calendar in which a subject's major life events are recorded, providing reference points to facilitate recall of specific jobs, and icons representing life events and jobs, which builds an easily-interpretable representation of the subject's life/work history. The icon/calendar questionnaire has been shown to produce a more complete picture of farmworkers' work histories than a traditional questionnaire [Engel et al., 2001]. Because there are no available records with which to validate the reported information, we used the self-reported work histories as the ''gold standard'' for determining the accuracy of the wives' responses. In reality, the accuracy of neither set of responses could be determined.

METHODS

Subjects

Thirty-two male farmworkers and their spouses were recruited in the Yakima area of central Washington State and were interviewed between May and October, 1996. The subjects were recruited mainly through an area church and a local farmworkers' union. Informed consent was obtained from all participants, and recruiting and interviewing were conducted in Spanish. The study protocol was approved by the Human Subjects Committees of both the University of Washington and the National Cancer Institute.

Interview

The interviews were conducted in an office setting. Each interview lasted up to approximately 1 h. Information on the farmworker's occupational history was collected using an interviewer-administered icon/calendar questionnaire, the details of which are presented elsewhere [Engel et al., 2001]. The farmworker was first asked for the age he began working. The interviewer sat next to the farmworker with a calendar containing rows labeled sequentially with the years between the farmworker's first reported job and the interview date, each marked with 12 months of the year. The interviewer then asked the farmworker to provide the month and year of important life events (e.g., birth, marriage, entry into the United States). The interviewer placed an icon (a small picture) representing each event at the appropriate date on a calendar. The farmworker was then asked detailed questions about his occupational history, starting with his first job and moving forward in time to the interview date. All jobs were recorded with icons on the calendar. Periods of unemployment were represented by a black line on the calendar, and periods that the farmworker could not recall were left blank. The life events icons were used by the interviewers to jog the farmworker's memory when appropriate. Spouses were intervewed simultancously but in separate rooms and were asked the same questions as farmworkers, except for wording changes to indicate that the questions were about the farmworker's activities rather than their own.

After the interviews were conducted, one pair was excluded from the data set because the farmworker was uncooperative, raising concerns about the validity of his self-reported work history. Thus, this study is based on the responses of 31 farmworker-spouse pairs.

Data Analysis

An overall assessment of the level of detail of the work histories provided by the two types of respondents was done by comparing the total number of jobs reported by all 31 farmworkers to the number reported by their spouses, as well as the median number of jobs reported by each set of respondents. A time period was counted as a ''job'' if the respondent identified a crop and/or task for that period or reported that the farmworker was unemployed. Each time a crop or task changed, or a worker became unemployed, it was considered a new job. We also examined the detail of the work histories separately for the time periods before and after marriage, and for each of four calendar time periods: prior to January 1986, January 1986 through December 1990, January 1991 through December 1995, and January 1996 through the date of interview. A job was included in a time period if it was held at any time during that period. As a result, a job spanning two time periods was counted twice; thus, the sum of jobs across the four time periods exceeds the total number of jobs reported. The analysis by time period was performed because (1) work and pesticide use patterns change over time, (2) recall is likely to vary over time, and (3) in order to compare our results with those from a companion study [Engel et al., 2001].

We compared the amount of time for which any job (or period of unemployment) was identified and we assessed the total number of years and the median number of years for which jobs were reported by the farmworkers compared to the spouses.

The accuracy with which spouses reported that the farmworkers had ever/never performed selected work or crop/task combinations that relate to potential pesticide exposure was examined. The seven types of work were: general agricultural jobs in Washington, apple-related jobs, cherry-related jobs, harvesting, thinning, applying pesticides, and thinning apples. The sensitivity and specificity of the spouses' histories for each combination of job type and time period was noted.

Three statistics were used to compare the duration of employment reported for each type of job and time period. The Spearman correlation coefficient was used to examine the extent to which farmworkers' duration of employment would be ranked similarly based on self vs. surrogate responses. We used the median difference to assess bias and the interquartile range of the difference in reported values (IQR) to assess variability in response; these were used instead of the mean and standard deviation as measures of bias and variability because they are less sensitive to outliers in the data. For normally distributed data, the IQR corresponds to an interval of ± 0.67 standard deviations about the mean.

TABLE I. Selected Characteristics of 31 Farmworkers

	Median (range)
Age at interview (years)	36 (21–72)
Age at first job (years)	10 (4–16)
Age at marriage (years)	25 (18–46)
Years in U.S.	16 (3–56)
Start date of work history	1971 (1935–1987)
Year of marriage	1987 (1954–1995)
Years of education	6 (0–12)

RESULTS

Demographics

The 31 farmworkers included in this study were all male Hispanics born in Mexico. At the time of the interview, they ranged in age from 21 to 72 years, with a median of 36 years (Table I). Their median age at marriage was 25. Half of the farmworkers were married before 1987; one was married as recently as 1995.

The median start date of the work histories was 1971. Most of the farmworkers were born on family farms and started working on these farms at an early age. Half of the farmworkers were under the age of 10 at the start of their first reported job; one subject was four years old. Fifty-four percent of the total number of years of work (or unemployment) reported by the farmworkers occurred prior to marriage.

Agreement—Life Events

Agreement between the farmworkers and spouses for the timing of reported life events (date of birth, date first came to the U.S., date first married, and birth date of first child) was high (Table II). The median differences ranged from 0 to 1 month. The greatest discrepancies were found in the year the farmworker first came to the U.S.; the upper end of the IQR was just over one year and the maximum discrepancy was 10.5 years.

Detail and Coverage of Work Histories

Work histories provided by the farmworkers contained more jobs and accounted for more time than those provided by their wives (Tables III and IV). Including periods of unemployment as ''jobs'' and ''work,'' the 31 farmworkers reported a total of 5,358 jobs, accounting for 877 years of work; their spouses identified 3,664 jobs (68%), accounting for 664 years of work (76%). The median number of jobs reported by spouses was less than half of the median number reported by farmworkers, and the median number of years was 75% of the farmworkers' median. Seven of the farmworkers had periods of time within their work histories for which they could identify neither the task they performed nor the crop they worked with; such gaps were present in 26 of the spouses' histories (data not shown).

The number of jobs and years reported by spouses were closer to those reported by farmworkers during the period after marriage than the period before. Spouses reported 81% of the number of farmworkers' jobs after marriage vs. 48% before marriage, and 84% of the years worked after marriage compared to 69% before. Of the four calendar time periods examined, spouses' work histories were most complete for jobs held in the most recent period (1996, the year the interview was conducted). Spouses accounted for all of the farmworkers' time in this period, with no gaps in the work histories, although the spouses histories contained only 76% of the number of jobs reported by the farmworkers. In all time periods, the percent of the farmworkers' time accounted for by spouses was higher than the percent of jobs accounted for. The same pattern was observed for the median number of jobs.

According to the farmworkers, only a small proportion (5%) of the jobs (or periods of unemployment) were held for periods of 6 months or more, yet these jobs accounted for 46% of the total number of years worked (data not shown). Spouses reported almost 100% of the number of farmworkers' jobs that were held for 6 months or more vs. 67% of the shorter jobs. Spouses reported 89% of the years spent in the longer jobs vs. 64% of the years spent in jobs held for less than 6 months.

TABLE II. Timing of Reported Life Events for Farmworkers: Agreement Between Farmworkers and Spouses

	Number of pairs	Median Δ (IQR)(months)
Birth date	30	0.0 (−0.1, 0)
First came to U.S.	31	1.0 (−9.0, 13.5)
First married	29	0.5 (−2.0, 1.4)
First child	23	0.5 (0.0, 0.5)

TABLE III. Number of Jobs, Farmworkers (FWs) vs. Spouses

	Total		Median	
	FW	Spouse	FW	Spouse
Total work history	5,358	3,664 (68%)	157	65 (41%)
Before 1/1/86	2,648	1,894 (72%)	77	25 (32%)
1/1/86–12/31/90	1,339	767 (57%)	34	22 (65%)
1/1/91–12/31/95	1,266	921 (73%)	34	25 (74%)
1/1/96–Interview	171	130 (76%)	4	4 (100%)
Before marriage	2,074	988 (48%)	57	16 (28%)
After marriage	3,284	2,676 (81%)	57	40 (70%)

Accuracy of Occupational Histories: Ever/Never Held Specific Jobs

The data were analyzed to determine the accuracy with which spouses reported that the farmworker ever/never held each of seven categories of jobs (Table V). Three of these job categories (agricultural jobs in Washington, apple-related jobs, and harvesting) were held by virtually all of the farmworkers, and spouses rarely failed to include them in the occupational histories. Jobs involving thinning crops, and thinning apples in particular, were each held by over 80% of the farmworkers. Sensitivities were 100% for both of these job categories, but specificities were lower. For cherry-related jobs (71% of farmworkers), sensitivity was 91% and specificity was very low. About half of the subjects reported applying pesticides at some point in their lifetime, for which the sensitivity was 60% and the specificity was 88%.

For the two earlier calendar time periods, sensitivities were low ($\leq$77%) and specificities ranged from 40 to 92%, indicating that the spouses had poor to moderate knowledge of the specific types of jobs their husbands held during each of these time periods. The wives performed best overall in the most recent time period; for all jobs except general thinning and thinning apples, sensitivities were at least 80% and specificities were at least 88%. For this time period, accuracy was highest for Washington agriculture, apple-related jobs, and applying pesticides.

Agreement of Occupational Histories: Duration of Employment

Table VI shows summary statistics for job duration. The correlation between cumulative lifetime duration of all jobs (including unemployment) reported by farmworkers and spouses was 0.78. There was substantial under-reporting by the spouses. More than 75% of the farmworkers accounted for more years than did their spouses.

Agreement with respect to duration of work varied by time frame. Agreement was better after marriage than before for all job categories; correlations were consistently higher after marriage, median differences were lower (compared to the self-reported medians), and variability was lower (i.e., the IQRs comprised a smaller percentage of the self-reported medians). A comparison of the results for the four calendar time periods shows that correlations were consistently lowest in the second time period (1986–1990). Agreement was best by all measures in the most recent time

TABLE IV. Number of Years Accounted For, FWs vs. Spouses

	Total		Median	
	FW	Spouse	FW	Spouse
Total work history	877	664 (76%)	25.6	19.1 (75%)
Before 1/1/86	560	427 (76%)	15.5	12.9 (83%)
1/1/86–12/31/90	149	96 (64%)	4.9	3.9 (80%)
1/1/91–12/31/95	153	124 (81%)	4.9	4.7 (96%)
1/1/96–Interview	16	16 (100%)	0.5	0.5 (100%)
Before marriage	471	323 (69%)	12.8	10.1 (79%)
After marriage	406	341 (84%)	9.0	8.6 (95%)

TABLE V. Accuracy of Spouses' Occupational Histories (Ever/Never), by Job Type and Time Period

	Number of FWs		Sensitivity	Specificity
	FW	Spouse	(%)	(%)
Washington agriculture				
Total work history	31	31	100	NA
Before 1/1/86	22	16	68	89
1/1/86–12/31/90	24	19	71	71
1/1/91–12/31/95	30	31	100	0
1/1/96–Interview	29	27	93	100
Apple-related jobs				
Total work history	30	30	100	100
Before 1/1/86	21	17	76	90
1/1/86–12/31/90	22	21	77	56
1/1/91–12/31/95	27	29	100	50
1/1/96–Interview	23	23	96	88
Cherry-related jobs				
Total work history	22	27	91	22
Before 1/1/86	12	11	58	79
1/1/86–12/31/90	14	8	29	76
1/1/91–12/31/95	18	20	72	46
1/1/96–Interview	7	9	86	88
Harvesting				
Total work history	31	30	97	NA
Before 1/1/86	26	21	77	80
1/1/86–12/31/90	26	20	65	40
1/1/91–12/31/95	26	24	88	80
1/1/96–Interview	10	9	80	95
Thinning				
Total work history	26	27	100	80
Before 1/1/86	20	12	55	91
1/1/86–12/31/90	15	11	47	75
1/1/91–12/31/95	19	19	89	83
1/1/96–Interview	10	9	70	90
Applying pesticides				
Total work history	15	11	60	88
Before 1/1/86	9	6	44	91
1/1/86–12/31/90	7	7	71	92
1/1/91–12/31/95	8	9	75	87
1/1/96–Interview	6	7	100	96
Thinning apples				
Total work history	25	27	100	67
Before 1/1/86	17	11	53	86
1/1/86–12/31/90	15	11	47	75
1/1/91–12/31/95	19	19	89	83
1/1/96–Interview	10	9	70	90

period for three of the job categories (Washington agriculture, apple-related jobs, and applying pesticides); for the other time periods and job types, the findings varied.

Overall, agreement was higher for Washington agricultural jobs and for apple-related jobs than for the other types of jobs. Except for 1986–1990, correlations were above 0.60 for each time period examined, and the median differences never exceeded 25% of the median values. Variability in the responses was high for some time periods (e.g., for apple-related jobs in the earliest time period), although lower than for other types of jobs. Agreement was lower for harvesting and pesticide application jobs. Correlations were below 0.50 for most of the individual time periods examined. Variability was quite high for these jobs, exceeding 100% of the median value for almost all of the time periods. Agreement was quite low for cherry-related jobs, thinning, and thinning apples. The correlations for cherries were negative for each of the four calendar time periods. For thinning and thinning apples, correlations were negative for all time periods except the earliest.

DISCUSSION

Consistent with the findings from other studies, many of which address populations that differ substantially from farmworkers in socioeconomic status, the work histories provided by farmworker spouses contained fewer jobs (68%) and accounted for less time (76%) than those provided by self-respondents. Lerchen and Samet [1986] compared occupational histories provided by subject-spouse pairs and found that wives under-reported the number of jobs their husbands held (73% of full-time jobs, 50% of part-time jobs) and number of years worked (82% for full-time employment, 39% for part-time employment). Pickle et al. [1983] compared the average number of jobs reported by case-control study subjects who were interviewed directly with the number reported by spouses of deceased subjects. The number of jobs reported by spouses of deceased white males was 73% of the number reported by white male self-respondents; the percentages for black males, white females, and black females were 59, 58, and 68%, respectively. Coggon et al. [1985] compared occupational histories from 31 subject-spouse pairs and found that the number of occupational units, occupational orders, industrial units, and industrial orders reported by spouses ranged from 51 to 73% of the number self-reported. Blot et al. [1978] and Rocca et al. [1986] found that surrogates other than spouses also under-reported the number of jobs.

The quality of the spouses' work histories was better for the period after marriage than before, and for the two more recent calendar time periods than for the two earlier ones. This is also consistent with other studies. Pickle et al. [1983] found that surrogates were best able to respond to questions concerning events that occurred while they shared the same household, and Coggon et al. [1985] found that most of the jobs that wives failed to report had been held early in the husbands' working lives. Lerchen and Samet [1986] found

TABLE VI. Agreement Between FW and Spouse: Job Duration (Months)

	Spearman		Median		
	Pairs	r	Self	Spouse	Median Δ(IQR)
Total work history	31	.78	307	229	55 (3, 120)
Before 1/1/186	30	.86	186	154	25 (0.4, 88)
1/1/86–12/31/90	31	.03	59	47	12 (−0.3, 47)
1/1/91–12/31/95	31	.04	59	56	3 (−0.2, 20)
1/1/96–Interview	31	.97	6	6	0 (0, 0)
Before marriage	31	.41	153	121	29 (−3, 112)
After marriage	31	.94	108	103	0.6 (−0.3, 6)
Washington agriculture					
Total work history	31	.70	82	50	11 (−7, 52)
Before 1/1/86	23	.73	36	15	5 (−5, 17)
1/1/86–12/31/90	26	.47	38	27	9 (−2, 23)
1/1/91–12/31/95	31	.78	34	28	3 (−2, 16)
1/1/96–Interview	29	.89	4	4	0.2 (−0.1, 0.8)
Before marriage	20	.57	40	9	10 (−1, 31)
After marriage	31	.77	45	45	5 (−4, 12)
Apple-related jobs					
Total work history	30	.65	42	26	2 (−11, 21)
Before 1/1/86	22	.61	20	11	2 (−8, 7)
1/1/86–12/31/90	26	.47	21	11	−1 (−4, 11)
1/1/91–12/31/95	29	.72	19	13	0.8 (−2, 10)
1/1/96–Interview	24	.90	3	3	0 (−0.3, 0.9)
Before marriage	18	.62	27	10	6 (−7, 14)
After marriage	30	.77	20	18	0.4 (−4, 7)
Cherry-related jobs					
Total work history	29	.41	4	3	−0.5 (−3, 4)
Before 1/1/86	16	−.11	2	2	0.1 (−2, 6)
1/1/86–12/31/90	18	−.46	2	0	2 (−2, 4)
1/1/91–12/31/95	25	−.08	2	2	−0.2 (−2, 2)
1/1/96–Interview	10	−.14	0.4	0.6	−0.1 (−2, 0.5)
Before marriage	15	.19	2	2	1 (−1, 5)
After marriage	25	.53	2	3	−0.8 (−3, 2)
Harvesting					
Total work history	31	.44	43	31	14 (−16, 33)
Before 1/1/86	27	.52	26	16	4 (−12, 22)
1/1/86–12/31/90	29	.13	10	6	3 (−4, 8)
1/1/91–12/31/95	27	.31	10	8	0.8 (−4, 7)
1/1/96–Interview	11	.25	0.8	0.3	0 (−0.4, 0.8)
Before marriage	28	.31	24	13	8 (−13, 25)
After marriage	30	.85	16	17	0.6 (−5, 10)
Thinning					
Total work history	27	.13	10	6	2 (−2, 14)
Before 1/1/86	21	.33	4	4	1 (−2, 3)
1/1/86–12/31/90	19	−.43	4	2	2 (−2, 6)
1/1/91–12/31/95	21	−.09	5	4	0 (−2, 4)
1/1/96–Interview	12	−.02	0.8	0.8	0.1 (−0.3, 0.7)
Before marriage	20	.22	6	0.7	2 (0.2, 10)
After marriage	25	.36	6	4	1 (−2, 3)

TABLE VI. (*Continued*)

	Spearman		Median		
	Pairs	r	Self	Spouse	Median Δ(IQR)
Applying pesticides					
Total work history	17	.58	10	6	3 (1, 14)
Before 1/1/86	11	.45	4	1	2 (−4, 4)
1/1/86–12/31/90	9	.16	5	4	2 (−3, 3)
1/1/91–12/31/95	11	.17	5	5	2 (−5, 9)
1/1/96–Interview	7	.64	4	1	0.4 (−0.4, 3)
Before marriage	9	−0.3	2	0	2 (1, 4)
After marriage	12	.63	15	11	3 (−4, 13)
Thinning apples					
Total work history	27	.07	8	5	1 (−2, 7)
Before 1/1/86	19	.32	4	4	0.6 (−2, 3)
1/1/86–12/31/90	19	−.40	3	2	2 (−2, 5)
1/1/91–12/31/95	21	−.12	5	4	0 (−2, 4)
1/1/96–Interview	12	−.02	0.8	0.8	0.1 (−0.3, 0.7)
Before marriage	16	.03	6	2	2 (−1, 4)
After marriage	25	.33	6	4	1 (−2, 3)

that for the most recent job, spouses work histories correctly reported 74% of the industries and 70% of the occupations.

The fraction of time covered by spouses' histories exceeded the fraction of jobs covered; this was true overall and for each time period. This is due in part to the fact that spouses reported a larger proportion of the longer jobs (i.e., jobs held 6 months or more) than the shorter jobs, a phenomenon observed by Lerchen and Samet [1986]. This could also be attributable to wives providing less detail about jobs than farmworkers. For example if a farmworker identified a specific apple-related task for April and May and a different apple-related task for June and July, we would have counted this as two jobs. If the spouse reported that the farmworker worked with apples throughout this time period but did not identify specific tasks, we would have counted this as one job. The amount of time covered would be the same in both cases.

The icon/calendar questionnaire was originally developed for the purpose of obtaining detailed work histories that could be used to impute pesticide exposure histories (see accompanying paper by Ward et al.). Based on the results of our study, the information that spouses can provide accurately would support only a crude, qualitative exposure assessment. Spouses accurately reported that all of the farmworkers held general agricultural jobs in the state of Washington, and the correlation in lifetime employment was reasonably high (0.70). However, pesticide exposures can vary substantially by crop type, task, and calendar time period, and spouses did not perform well for most of the specific job categories examined. It was encouraging that spouses performed moderately well for apple-related jobs (correlation in lifetime employment was 0.65), which were performed by all of the farmworkers for a relatively long period of time (median lifetime duration was 3.5 years). For cherry-related jobs, there was a high occurrence of false positives and the duration of employment correlated only modestly; however, these jobs were held by fewer farmworkers and for much shorter periods of time (median 4 months lifetime), making them less important in an exposure assessment. Spouses had only poor to moderate knowledge of their husbands' work with respect to specific tasks, including harvesting which had a prevalence of 100%. With respect to calendar time period, correlations for duration of employment in Washington agriculture and apple-related jobs were reasonably high (0.61–0.90) for all time periods except 1986–1990 (0.47). For the remaining job types, the correlations were below 0.50 and the variability was high.

Given the complexity of the work histories (half of the farmworkers reported over 157 jobs), the preponderance of jobs held for short periods of time (95% were held for less than 6 months), and the young age at which the farmworkers started working (median age of 10), the spouses' inability to provide accurate information for specific jobs and calendar time periods is not surprising. Some of the inaccuracy in the proxy-provided histories is due to the limited reliability of the questionnaire itself, which was evaluated in a separate test-retest reliability study [Engel et al., 2001]. The questionnaire was originally administered to 40 farmworkers and to the wives of those who were married at the time; these 31 pairs comprise the subjects of the current study. Eight to

14 months after the original interview, the 40 farmworkers were invited to be reinterviewed, and those who accepted comprise the subjects of the test-retest study. Twenty-three farmworkers participated in both studies. Similar to the current study, the test-retest analysis found that correlations in lifetime duration of employment were highest for general agricultural jobs in Washington (0.93) and apple-related jobs (0.92). For the other job categories, the correlations in job duration were moderate to poor (0.40–0.59) and the variability in responses was high. Interestingly, for the most recent calendar time period, the correlations for Washington agriculture and apple-related jobs were higher for the farmworker-spouse pairs than for the test-retest subjects. This is probably because the initial farmworker and spouse interviews were both conducted right at the end of this period, while the second farmworker interview was conducted after 8–14 months of delay.

The test-retest investigators concluded that the icon/calendar questionnaire is a valuable tool for obtaining complete information about farmworkers' work histories. However, the histories were only moderately reliable, and the investigators concluded that the strength of the questionnaire is in assessing the extent of agricultural employment by the rather broad categories of place and crop. This was also true in our study, in which work histories provided by spouses were considerably more accurate for Washington agriculture and apple-related jobs than for other job categories. The spouses' histories were less complete in terms of the number of jobs and time accounted for than the self-reported histories, suggesting that self-reported job histories should be used whenever possible. However, if study subjects have died or cannot be located for interview, and if the information collected in the work histories is used only for more generalized exposure assessments, our study indicates that spouses can be used to provide work histories for farmworkers. The histories will be more accurate for the period of time after the couple was married, and for jobs closer to the time of the interview. Presumably, the histories would be most accurate for the period of time that the couple migrated and worked together, a phenomenon which could not be examined based on the information collected in this study but could be assessed in future studies.

Future studies should also address the accuracy of the self-reported work histories. We used the self-reported histories as the gold standard for our analysis but did not have the resources to validate them. Depending on geographic location, growers' records, pesticide application reports, and biological samples could be used for validation purposes.

Finally, it should be made explicit that this study was comprised entirely of female proxies reporting on their husbands' occupational histories. The results are not necessarily representative of how well male proxies would report occupational histories for their wives.

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